What is claimed is:

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1. A method of film deposition, comprising:

forming a titanium nitride (TiN) layer on a substrate in a process chamber;

removing reaction by-products generated during titanium nitride (TiN) layer formation from the process chamber; and

exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer.

2. The method of claim 1 wherein the reaction by-products are removed from the process chamber by providing a purge gas thereto and evacuating both the purge gas and the reaction by-products therefrom.

3. The method of claim 2 wherein the purge gas comprises one or more gases selected from the group consisting of nitrogen (N_2), hydrogen (H_2), helium (He), argon (Ar), neon (Ne) and xenon (Xe).

4. The method of claim 2 wherein the purge gas is provided to the process chamber for up to about 5 minutes.

5. The method of claim 1 wherein the titanium nitride (TiN) layer is formed from a reaction of titanium tetrachloride ($TiCl_4$) and ammonia (NH_3).

6. The method of claim 1 wherein the silicon-containing gas is selected from the group consisting of silane (SiH_4) and disilane (Si_2H_6).

7. The method of claim 6 wherein the silicon-containing gas is mixed with one or more gases selected from the group consisting of hydrogen (H_2), nitrogen (N_2), argon (Ar) and helium (He).

8. The method of claim 7 wherein the silicon-containing gas is mixed with hydrogen (H_2).

9. The method of claim 8 wherein the ratio of the silicon-containing gas to the hydrogen (H_2) is greater than 1.

10. The method of claim 1 further comprising treating the titanium nitride (TiN) layer with a hydrogen-containing plasma prior to exposing the titanium nitride (TiN) layer to the silicon-containing gas.

11. The method of claim 10 wherein the titanium nitride (TiN) layer is treated after reaction by-products generated during titanium nitride (TiN) layer formation are removed from the process chamber.

12. The method of claim 10 wherein the titanium nitride (TiN) layer is treated before reaction by-products generated during titanium nitride (TiN) layer formation are removed from the process chamber.

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13. The method of claim 10 wherein the hydrogen-containing plasma is generated by applying an electric field to a gas mixture comprising one or more gases selected from the group consisting of hydrogen (H_2), ammonia (NH_3), hydrazine (N_2H_4), nitrogen (N_2), argon (Ar) and helium (He).

14. The method of claim 10 wherein the titanium nitride (TiN) layer is treated with the hydrogen-containing plasma for about 5 seconds to about 100 seconds.

15. A method of film deposition, comprising:

(a) forming a titanium nitride (TiN) layer on a substrate in a process chamber;

(b) removing reaction by-products generated during titanium nitride (TiN) layer formation from the process chamber;

(c) treating the titanium nitride (TiN) layer with a hydrogen-containing plasma;

(d) removing reaction by-products generated during titanium nitride

(TiN) layer formation from the process chamber; and

(e) exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer.

16. The method of claim 15 wherein the reaction by-products are removed from the process chamber in steps (b) and (d) by providing a purge gas thereto and evacuating both the purge gas and the reaction by-products therefrom.

17. The method of claim 16 wherein the purge gas comprises one or more gases selected from the group consisting of nitrogen (N_2), hydrogen (H_2), helium (He), argon (Ar), neon (Ne) and xenon (Xe).

18. The method of claim 16 wherein the purge gas is provided to the process chamber for up to about 5 minutes.

19. The method of claim 15 wherein the titanium nitride (TiN) layer is formed from a reaction of titanium tetrachloride ($TiCl_4$) and ammonia (NH_3).

20. The method of claim 15 wherein the silicon-containing gas is selected from the group consisting of silane (SiH_4) and disilane (Si_2H_6).

21. The method of claim 20 wherein the silicon-containing gas is mixed with one or more gases selected from the group consisting of hydrogen (H_2), nitrogen (N_2), argon (Ar) and helium (He).

22. The method of claim 21 wherein the silicon-containing gas is mixed with hydrogen (H_2).

23. The method of claim 22 wherein the ratio of the silicon-containing gas to the hydrogen (H_2) is greater than 1.

24. The method of claim 15 wherein the hydrogen-containing plasma is generated by applying an electric field to a gas mixture comprising one or more gases selected from the group consisting of hydrogen (H_2), ammonia (NH_3), hydrazine (N_2H_4), nitrogen (N_2), argon (Ar) and helium (He).

25. The method of claim 15 wherein the titanium nitride (TiN) layer is treated with the hydrogen-containing plasma for about 5 seconds to about 100 seconds.

26. A method of forming a barrier layer for use in integrated circuit fabrication, comprising:

forming a titanium nitride (TiN) layer on a substrate in a process chamber;

removing reaction by-products generated during titanium nitride (TiN) layer formation from the process chamber;

exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer; and

forming a metal layer on the titanium silicide nitride (TiSiN) layer.

27. The method of claim 26 wherein the reaction by-products are removed from the process chamber by providing a purge gas thereto and evacuating both the purge gas and the reaction by-products therefrom.

28. The method of claim 27 wherein the purge gas comprises one or more gases selected from the group consisting of nitrogen (N_2), hydrogen (H_2), helium (He), argon (Ar), neon (Ne) and xenon (Xe).

29. The method of claim 27 wherein the purge gas is provided to the process chamber for up to about 5 minutes.

30. The method of claim 26 wherein the titanium nitride (TiN) layer is formed from a reaction of titanium tetrachloride ($TiCl_4$) and ammonia (NH_3).

31. The method of claim 26 wherein the silicon-containing gas is selected from the group consisting of silane (SiH_4) and disilane (Si_2H_6).

32. The method of claim 31 wherein the silicon-containing gas is mixed with one or more gases selected from the group consisting of hydrogen (H_2), nitrogen (N_2), argon (Ar) and helium (He).

33. The method of claim 32 wherein the silicon-containing gas is mixed with hydrogen (H_2).

34. The method of claim 33 wherein the ratio of the silicon-containing gas to the hydrogen (H_2) is greater than 1.

35. The method of claim 26 further comprising treating the titanium nitride (TiN) layer with a hydrogen-containing plasma prior to exposing the titanium nitride (TiN) layer to the silicon-containing gas.

36. The method of claim 35 wherein the titanium nitride (TiN) layer is treated after reaction by-products generated during titanium nitride (TiN) layer formation are removed from the process chamber.

37. The method of claim 35 wherein the titanium nitride (TiN) layer is treated before reaction by-products generated during titanium nitride (TiN) layer formation are removed from the process chamber.

38. The method of claim 35 wherein the hydrogen-containing plasma is generated by applying an electric field to a gas mixture comprising one or more gases selected from the group consisting of hydrogen (H_2), ammonia (NH_3), hydrazine (N_2H_4), nitrogen (N_2), argon (Ar) and helium (He).

39. The method of claim 35 wherein the titanium nitride (TiN) layer is treated with the hydrogen-containing plasma for about 5 seconds to about

100 seconds.

40. A method of film deposition, comprising:

forming a titanium nitride (TiN) layer on a substrate in a first process chamber;

moving the substrate with the titanium nitride (TiN) layer thereon into a second process chamber different from the first process chamber; and

exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer.

41. The method of claim 40 wherein the titanium nitride (TiN) layer is formed from a reaction of titanium tetrachloride ($TiCl_4$) and ammonia (NH_3).

42. The method of claim 40 wherein the silicon-containing gas is selected from the group consisting of silane (SiH_4) and disilane (Si_2H_6).

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43. The method of claim 42 wherein the silicon-containing gas is mixed with one or more gases selected from the group consisting of hydrogen (H_2), nitrogen (N_2), argon (Ar) and helium (He).

44. The method of claim 43 wherein the silicon-containing gas is mixed with hydrogen (H_2).

45. The method of claim 44 wherein the ratio of the silicon-containing gas to the hydrogen (H_2) is greater than 1.

46. The method of claim 40 further comprising treating the titanium nitride (TiN) layer with a hydrogen-containing plasma prior to exposing the titanium nitride (TiN) layer to the silicon-containing gas.

47. The method of claim 46 wherein the titanium nitride (TiN) layer is treated after moving the substrate into the second process chamber.

48. The method of claim 46 wherein the titanium nitride (TiN) layer is treated before moving the substrate into the second process chamber.

49. The method of claim 46 wherein the hydrogen-containing plasma is generated by applying an electric field to a gas mixture comprising one or more gases selected from the group consisting of hydrogen (H_2), ammonia (NH_3), hydrazine (N_2H_4), nitrogen (N_2), argon (Ar) and helium (He).

50. The method of claim 46 wherein the titanium nitride (TiN) layer is treated with the hydrogen-containing plasma for about 5 seconds to about 100 seconds.

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~~51~~1. A method of film deposition, comprising:

(a) forming a titanium nitride (TiN) layer on a substrate in a first process chamber;

(b) removing reaction by-products generated during titanium nitride (TiN) layer formation from the first process chamber;

(c) treating the titanium nitride (TiN) layer with a hydrogen-containing plasma;

(d) moving the substrate with the titanium nitride (TiN) layer thereon into a second process chamber different from the first process chamber; and

(e) exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer.

52. The method of claim 51 wherein the reaction by-products are removed from the first process chamber in step (b) by providing a purge gas thereto and evacuating both the purge gas and the reaction by-products therefrom.

53. The method of claim 52 wherein the purge gas comprises one or more gases selected from the group consisting of nitrogen (N_2), hydrogen (H_2), helium (He), argon (Ar), neon (Ne) and xenon (Xe).

54. The method of claim 52 wherein the purge gas is provided to the process first chamber for up to about 5 minutes.

55. The method of claim 51 wherein the titanium nitride (TiN) layer is formed from a reaction of titanium tetrachloride ($TiCl_4$) and ammonia (NH_3).

56. The method of claim 51 wherein the silicon-containing gas is selected from the group consisting of silane (SiH_4) and disilane (Si_2H_6).

57. The method of claim 56 wherein the silicon-containing gas is mixed with one or more gases selected from the group consisting of hydrogen (H_2), nitrogen (N_2), argon (Ar) and helium (He).

58. The method of claim 57 wherein the silicon-containing gas is mixed with hydrogen (H_2).

59. The method of claim 58 wherein the ratio of the silicon-containing gas to the hydrogen (H_2) is greater than 1.

60. The method of claim 51 wherein the hydrogen-containing plasma is generated by applying an electric field to a gas mixture comprising one or more gases selected from the group consisting of hydrogen (H_2), ammonia (NH_3), hydrazine (N_2H_4), nitrogen (N_2), argon (Ar) and helium (He).

61. The method of claim 51 wherein the titanium nitride (TiN) layer is treated with the hydrogen-containing plasma for about 5 seconds to about 100 seconds.

~~62~~. A method of forming a barrier layer for use in integrated circuit fabrication, comprising:

forming a titanium nitride (TiN) layer on a substrate in a first process chamber;

moving the substrate with the titanium nitride (TiN) layer thereon into a

second process chamber different from the first process chamber;

exposing the titanium nitride (TiN) layer to a silicon-containing gas to convert the titanium nitride (TiN) layer to a titanium silicide nitride (TiSiN) layer; and

forming a metal layer on the titanium silicide nitride (TiSiN) layer.

63. The method of claim 62 wherein the titanium nitride (TiN) layer is formed from a reaction of titanium tetrachloride ($TiCl_4$) and ammonia (NH_3).

64. The method of claim 62 wherein the silicon-containing gas is selected from the group consisting of silane (SiH_4) and disilane (Si_2H_6).

65. The method of claim 64 wherein the silicon-containing gas is mixed with one or more gases selected from the group consisting of hydrogen (H_2), nitrogen (N_2), argon (Ar) and helium (He).

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66. The method of claim 65 wherein the silicon-containing gas is mixed with hydrogen (H_2).

67. The method of claim 66 wherein the ratio of the silicon-containing gas to the hydrogen (H_2) is greater than 1.

68. The method of claim 62 further comprising treating the titanium nitride (TiN) layer with a hydrogen-containing plasma prior to exposing the titanium nitride (TiN) layer to the silicon-containing gas.

69. The method of claim 68 wherein the titanium nitride (TiN) layer is treated after the substrate with the titanium nitride (TiN) layer thereon is moved into the second process chamber.

70. The method of claim 68 wherein the titanium nitride (TiN) layer is treated before the substrate with the titanium nitride (TiN) layer thereon is moved into the second process chamber.

72. The method of claim 68 wherein the hydrogen-containing plasma is generated by applying an electric field to a gas mixture comprising one or more gases selected from the group consisting of hydrogen (H_2), ammonia (NH_3), hydrazine (N_2H_4), nitrogen (N_2), argon (Ar) and helium (He).

73. The method of claim 68 wherein the titanium nitride (TiN) layer is treated with the hydrogen-containing plasma for about 5 seconds to about 100 seconds.

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